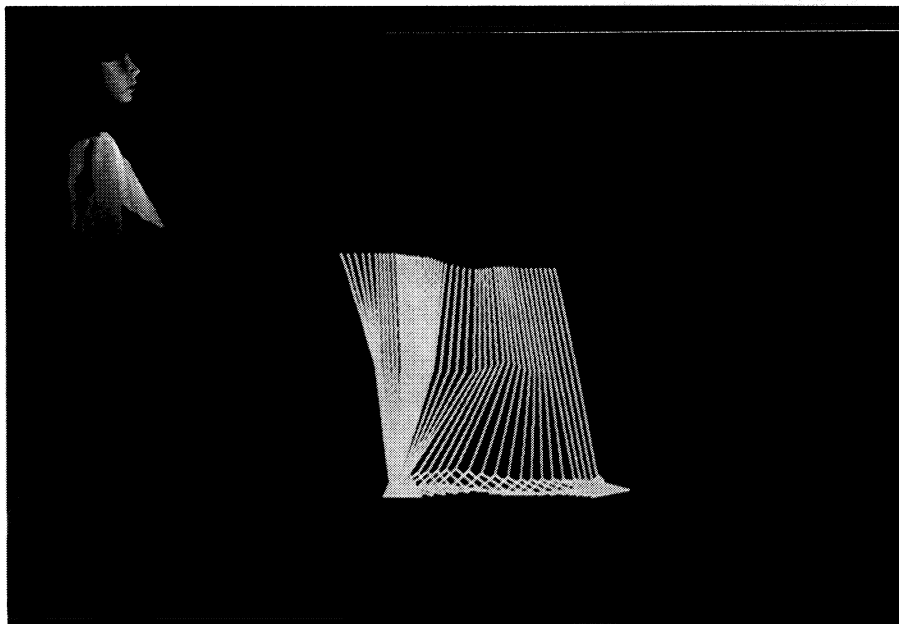


New Help for the Handicapped

A space-derived biotelemetry system heads a representative group of spinoffs in the field of health and medicine



The motion Analysis Laboratory of Children's Hospital at Stanford is conducting tests of walking impaired children to study muscle movement as an aid to prescribing treatment. The laboratory uses a telemetry system to measure the degree and location of abnormal muscle activity. Leg sensors, shown at far right, send wireless signals to a computer, which develops pictures of gait patterns for use by physicians and therapists.

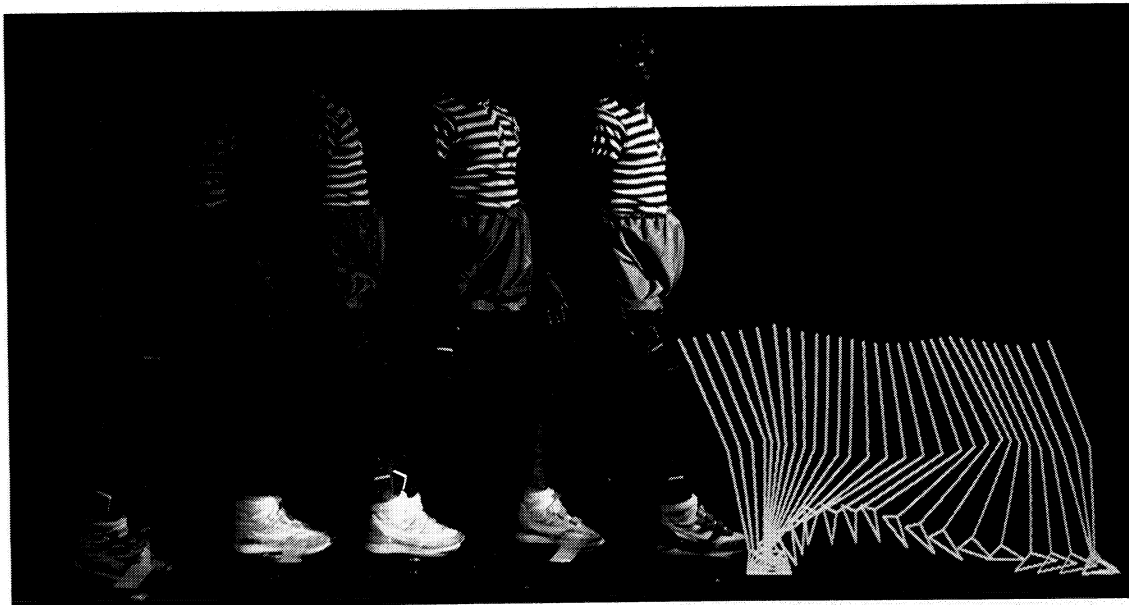
Telemetry is a process whereby data acquired in orbit is sent to Earth by radio in the form of coded signals, which are decoded on the ground to become useful information. The technique has been employed advantageously in a number of Earth applications, for example, collecting weather, air pollution and water quality data from remote locations, or sending flow measurements from unattended oil wells to a central data repository.

Biotelemetry is a specialized form of telemetry in which the coded signals contain physiological information. It has been used extensively in the U.S. space program as a means of monitoring astronaut vital functions from the ground.

Spinoff uses of biotelemetry include its employment by physicians to "interrogate" human-implanted devices and by hospitals to monitor the conditions of a number of patients from a single location. A new and important medical application, in development for more than a decade, is use of biotelemetry as a diagnostic tool in treatment of patients who experience difficulty walking due to birth defects, disease or injury.

Such disorders affect the nervous system, causing muscular spasticity and loss of coordination. The individual muscles affected vary widely, so it is difficult to determine, by physical examination alone, which muscle groups are most involved. But through a process called electromyography—the recording of electrical activity in the muscles—physicians can identify the offending muscles for development of remedial strategy. Sophisticated laboratory equipment can detect the degree and location of abnormal muscle activity, monitor changes and help the physician in prescribing treatment.

At a score of U.S. hospitals, a space-derived biotelemetry system is providing important assistance in electromyographic analyses. The Gait Analysis Telemetry System—a cooperative development of NASA, Children's Hospital at Stanford, Palo Alto, California and L&M Electronics Inc., Daly City, California—enables physicians to obtain detailed information on a patient's leg muscle action during walking tests. Miniature sensor/



transmitters, each about the size of a half dollar, are affixed directly over the muscle group being studied. Each transmitter has its own tiny lithium battery and a pair of sensing electrodes. The muscle activity sensed—called an EMG, for electromyogram—is sent to a computer for analysis and display.

The system's big advantage lies in the fact that telemetry signals are transmitted without wires. Other means of monitoring EMG involve wires connecting leg sensors with a receiver/recorder. But the wires, and an associated battery pack worn on the patient's waist, may hamper the subject's walking pattern and thus reduce the accuracy of the information sought. The spinoff system records the *true* gait pattern, providing an important assist to the physician or therapist.

The basic L&M Electronics receiving unit has four channels, but its informational capacity can be increased by adding additional channels in increments of four. Several hospitals employ eight channel systems to allow simultaneous acquisition of EMG signals from several transmitters; in a typical eight channel test, the patient has three sensor/transmitters on each leg, plus one on each foot to send information on exactly which parts of the foot touch the floor.

An example of the system's use is the work of the Motion Analysis Laboratory of Children's Hospital at Stanford. The laboratory conducts walking tests of children afflicted with cerebral palsy, muscular

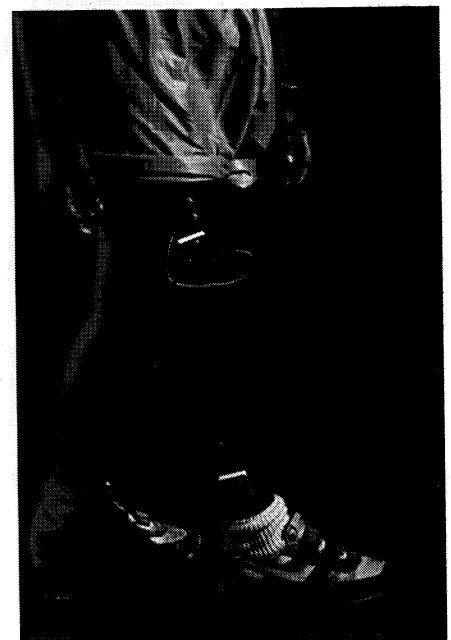
dystrophy, congenital disorders or injuries. The telemetry system records, measures and analyzes muscle activity in the limbs and spine; its information is available in printed readout form and in computer-developed pictures of gait patterns. This information helps physicians determine the potential of corrective surgery, evaluate various types of braces, or decide whether physical therapy may improve a child's function. The laboratory's success in this type of service has made Children's Hospital at Stanford a regional center for patients referred from other hospitals in the area.

The same biotelemetry system is being used in a research program at the nearby Rehabilitation Research and Development Center (RRanD) of the Veterans Administration Medical Center, Palo Alto, California, where Dr. Michael Zomlefer, in collaboration with Dr. Ronald Gaines of the Spinal Cord Injury Center, are investigating the possibility of restoring locomotor function to patients with spinal cord injuries and others with severe gait disorders.

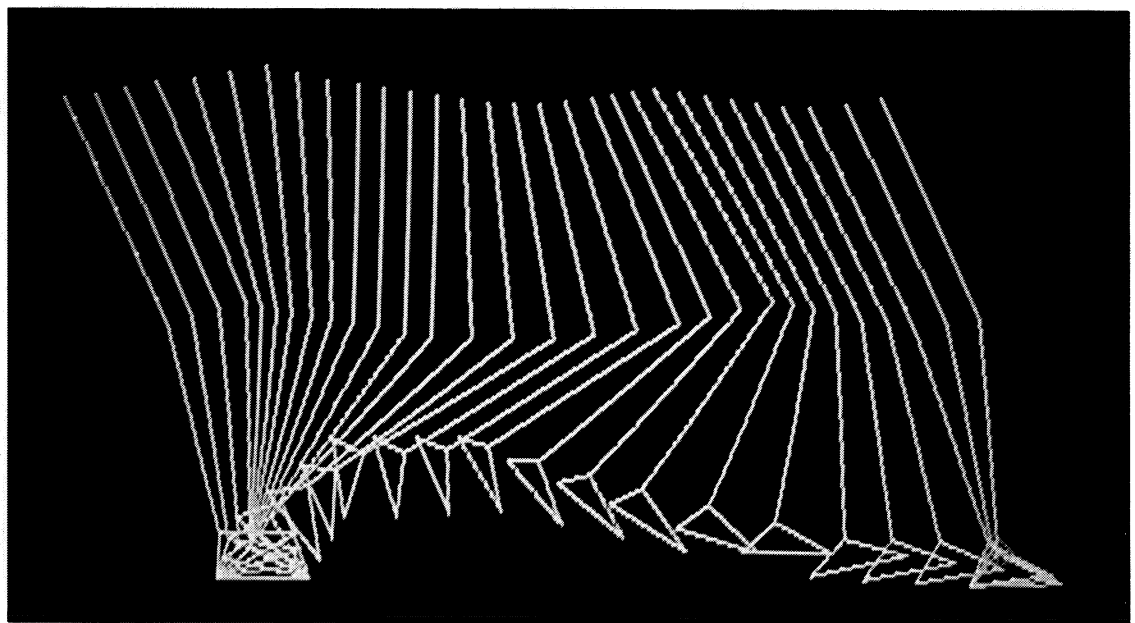
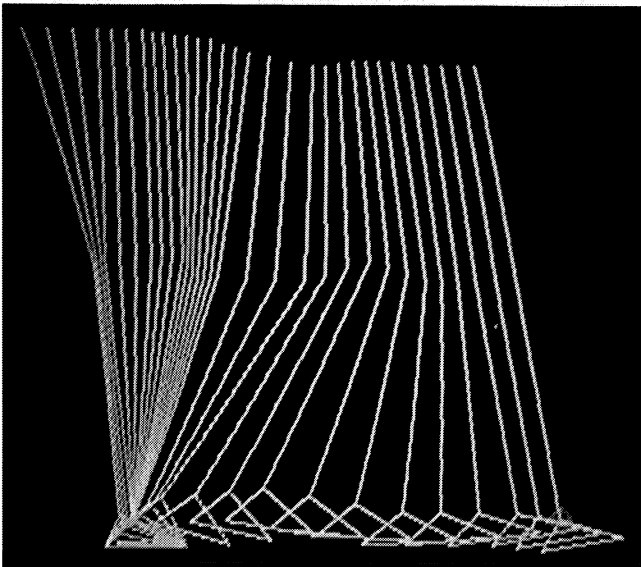
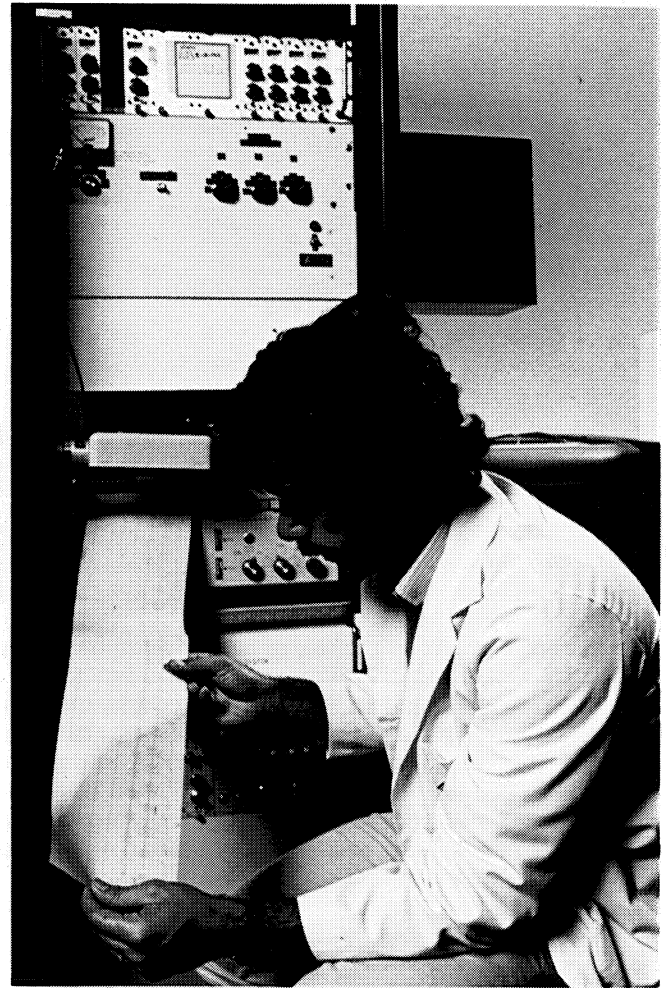
Experimental work with animals has shown that many mammals can perform stepping locomotor activity even after a complete spinal cord transection. It is not known whether humans with spinal cord transections can perform stepping movements. That is what Drs. Zomlefer and Gaines and their associates at RRanD are investigating. Volunteer patients are suspended in a modified parachute harness over a moving treadmill belt. The only stimulus to

the patient is the contact of the foot with the belt. Any movement is recorded by a video system, while the telemetry system measures electromyographic activity in the lower limb muscles.

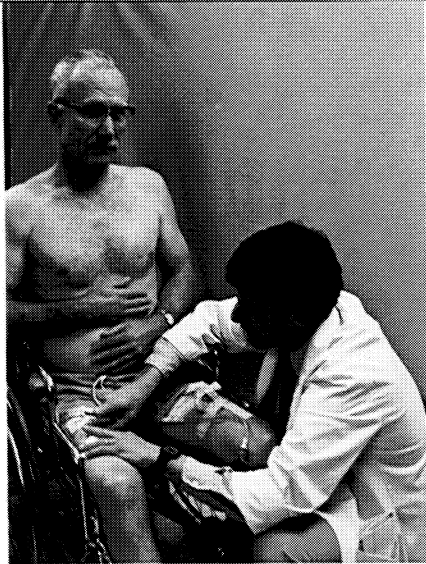
The thesis of this study is that humans possess some form of spinal "pattern generator" for locomotion. Say Drs. Zomlefer and Gaines: "The presence of spinal stepping in our subjects would strengthen the relevance of existing animal work in the area, and create the groundwork for more quantitative studies with human subjects. Evidence leading to the existence of spinal locomotor pattern generators would be an exciting development, suggesting the possibility of simple controllers for the generation of locomotion in humans with cord injuries."



At right, Neil Adler, director of the Motion Analysis Laboratory of Children's Hospital at Stanford, studies a computer printout of a walking test measured by the Gait Analysis Telemetry System. The computer produces video images of walking patterns as an aid to determining remedial measures for children whose mobility is restricted. The photo below shows a normal walking pattern; the bottom photo pictures an abnormal gait.



At the Rehabilitation Research and Development Center of the Veterans Administration Medical Center, volunteer paraplegic Howard Baxter is being readied for a locomotion test (right). At far right, the patient is suspended over a moving treadmill belt, while Dr. Michael Zomlefer (left in photo) and Dr. Ronald Gaines move his legs. The telemetry system records signals received from the muscle sensors and indicates whether there is any vestige of locomotion.



In a related project at the Veterans Administration Rehabilitation Research and Development Center, Drs. Curt Boylls, Felix E. Zajac and Michael R. Zomlefer are developing computerized muscle models and studying the muscle activity involved in various forms of human locomotion. One experiment involves use of a bicycle "ergometer," a stationary pedaling machine in which one leg pedals at a different speed than the other in a study of interlimb coordination. Above,

biomedical engineer Douglas Schwandt demonstrates the machine he helped design and construct. The sensors shown in the closeup view below transmit muscle data for computer analysis.

